

# REVIEW RESOURCES

## Lesson 18: Science and Technology in the Acquisition Process

### U.S. Technology Posture

#### Defining Science and Technology

Science is the broad body of knowledge derived from observation, study, and experimentation. It includes:

- Physics
- Biology
- Material sciences
- Chemistry
- Geophysics
- Mathematics

Technology is the practical application of scientific knowledge.

#### Science and Technology Base

Many past technological advances were linked to defense development. Several "firsts" were developed to ensure national security in times of crisis or warfare. Such advances include:

- Telegraph
- Mass-produced jet aircraft
- Stealth technology
- Atomic power
- Laser
- Radar

To ensure dominance in future warfare, the United States is committed to maintaining a solid and strong science and technology program. This technology base is the nation's premier combat force multiplier.

#### Technology Transition

Technology transition is a function/goal of the Systems Engineering Process.

- In peacetime, technological superiority is a key element for deterrence of conflict.
- During crisis, technological superiority provides a wide range of options to the Commanders-in-Chief (CINCs), while providing confidence to our allies.
- In war, technological superiority enhances combat effectiveness, reduces casualties, and minimizes equipment loss.

#### The Military's Changing Role in Science and Technology

In the mid-1970's, there was a shift in the origin of new technology breakthroughs. No longer was the

defense establishment the primary source of new technology. Commercial consumer technology began to provide many "firsts." The military emphasis shifted from developing new technologies to leveraging commercially developed applications.

### Defense Science and Technology Program Foundations

The Defense Science and Technology program:

- Needs to be grounded in a deep understanding of fundamental science and technology.
- Uses this understanding to create new military capabilities to counter security threats.
- Responds to what the warfighters need.
- Does not duplicate what the commercial marketplace can produce cheaper and faster.

Remember that science and technology play a critical role in peacetime as well as during times of conflict. Our technology base is our foremost force multiplier and an important national economic asset.

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## Science and Technology Continuum

### Budget Categories

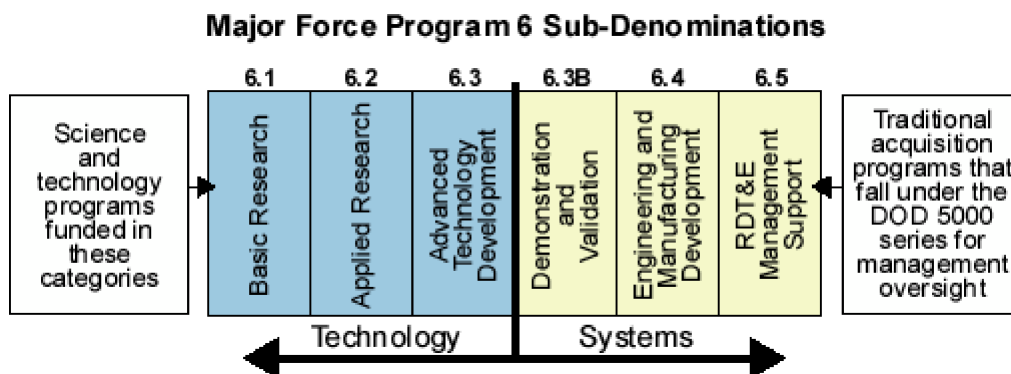
The science and technology program is managed in the following three Research, Development, Test, and Evaluation (RDT&E) budget categories:

- Basic Research (RDT&E Budget Category 6.1)
- Applied Research (RDT&E Budget Category 6.2)
- Advanced Technology Development (RDT&E Budget Category 6.3).

Research, Development, Test, and Evaluation (RDT&E) budget categories are separately funded but related. The difference in funding between acquisition programs and science and technology can be explained by reviewing the RDT&E appropriation.

### Research, Development, Test, and Evaluation (RDT&E) Appropriation

The chart below shows the six RDT&E budget categories implemented in the Future Year Defense Plan (FYDP).



### Basic Research: Category 6.1

The first applicable RDT&E budget category used to fund basic research is category 6.1. Basic research includes scientific studies that increase fundamental knowledge in fields such as computer

science, chemistry, electronics, and materials. The objective is to create or exploit scientific breakthroughs and guard against technological surprise.

Colleges and universities conduct 60% of DOD's basic research; DOD and Federal Labs conduct 25%; and industry and nonprofit organizations conduct 15%.

### **Applied Research: Category 6.2**

The second applicable RDT&E budget category used to fund applied research is category 6.2. DOD funds applied research through RDT&E budget category 6.2. Applied research:

- Focuses on maturation of technologies before they are considered for transition to advanced development.
- Includes applying basic research to solving specific military problems.

Concepts proving to have merit are formulated into possible technological solutions. These solutions are evaluated based on the feasibility and practicality of their technological application.

### **Ten Key Areas of Importance to Future Military Needs**

Applied research focuses on those technologies in the 10 key areas, as reflected in the Defense Technology Area Plans (DTAPs) that have the highest relative importance to future military needs. The following areas are described in 10 Technology Areas Plans (TAPs):

- Air Platforms
- Chemical/Biological and Nuclear Defense
- Information Systems and Technology
- Ground and Sea Vehicles
- Materials/Processes
- Biomedical
- Sensors, Electronics, and Battlespace Environment
- Space Platforms
- Human Systems
- Weapons

### **Advanced Technology Development: Category 6.3**

The third applicable RDT&E budget category used to fund advanced technology development is category 6.3. This category focuses on the development of components, subsystems, and advanced technology demonstrations with potential application to a variety of similar products rather than application to one specific system.

### **Technology Progression**

The F-117, B-2, and other stealth aircraft provide an excellent example of how technology progresses through basic research (6.1), applied research (6.2), advanced technology development (6.3), and finally into system development.

### **Basic Research RDT&E Budget Category 6.1**

Basic research efforts were conducted in the late 60's and early 70's dealing with mathematical analysis of radar wave reflectivity from various geometric shapes. Other efforts studied the absorption/reflection characteristics of various materials.

## Applied Research RDT&E Budget Category 6.2

The basic research efforts led to 6.2-level investigations. The mathematical analysis of geometric shapes evolved into studies of how low-reflectivity shapes could serve as aerodynamic components (air foils, fuselage). Work continued to determine if low absorption materials could serve as structural components of an airframe or be applied to structural components.

## Advanced Technology Development RDT&E Budget Category 6.3

Finally, a technology demonstrator was built. Initially, this demonstrator was highly classified. This demonstrator ultimately led to operational aircraft such as the F-117 and B-2.

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## Introducing Technology Into Acquisition Phases

### Research Application

DOD funds basic research institutes in a dozen Science and Engineering Disciplines, but only a small portion of research findings is incorporated into military or defense systems.

Research is often found to be infeasible for application or not mature enough to be incorporated into the acquisition process. A program manager must decide when it is appropriate to incorporate new technology into an acquisition program.

### Twelve Basic Research Science and Engineering Disciplines

The 12 Basic Research Science and Engineering Disciplines funded by the DOD include:

- Physics
- Mechanics
- Chemistry
- Terrestrial Science
- Mathematics
- Ocean Sciences
- Computer Science
- Atmospheric and Space Science
- Electronics
- Biological Science
- Materials Science
- Cognitive and Neural Science

### When To Incorporate Technology

The decision to transition new technology into an acquisition program requires:

- An objective assessment of the maturity level of a given technology.
- Cooperation, understanding, and effective communications among the users, acquirers, and Science and Technology managers.

### Determination of Mission Needs

Science and Technology managers and users focus on new ideas that could meet the warfighters needs during the Mission Area Analysis. If the analysis shows that a materiel solution is needed, a Mission Need Statement is prepared, and the acquisition process is begun.

### **Concept Exploration**

As concepts are considered, the benefits and risks of the candidate technologies are reviewed to understand the impact of each approach.

- Selecting unproven technology can introduce significant risk.
- Selecting proven technology can pay off in cost, schedule, and performance.

### **Program Definition and Risk Reduction**

As the design matures, introducing new technology can cause significant changes to the system baseline.

- New technology can often be incorporated as a pre-planned product improvement to the original baseline.
- Technologies involving new manufacturing techniques are often incorporated into the design during this phase.

### **Engineering and Manufacturing Development (EMD)**

EMD's goal of maturing and stabilizing the design is often inconsistent with introducing new technology at this point in a program. Insertion of technology into parallel system modifications and Service Life Extension Programs can be planned based on changing user needs, such as:

- Changing threats
- The need for more cost-efficient systems
- New technological opportunities

### **Production, Fielding/Deployment, and Operational Support (PF/DOS)**

During the Production and Fielding/Deployment portions of this phase, new technologies are typically introduced as part of a pre-planned product improvement program.

During the Operational Support portion of this phase, system modifications may be developed that inject new technology into the system throughout its life. These are typically managed as new or distinct programs.

### **Demilitarization and Disposal**

It may be many years between the development of a system and its demilitarization and disposal. New technologies can be used to dispose of these systems properly. Often new technologies are needed to comply with current requirements:

- Legal
- Environmental
- Safety

### **Principles for Successful Technology Integration**

Program managers can reduce the risk associated with integrating technology by adhering to four underlying principles that govern the successful transition of technology into military systems. The

underlying principles for successful technology integration are:

- Ensure technology is focused on critical military needs.
- Establish a technology transition approach to define tasks and resources needed to accomplish the transition.
- Define transition criteria and the implementation method for incorporating technology.
- Conduct periodic reviews in conjunction with laboratories, users, and maintainers.

### Criteria for Incorporating Technology

A program office should develop criteria for incorporating advanced technology into an acquisition. The office may consider several criteria, but there are three criteria that have proven to increase success and reduce risk and therefore should be included.

CRITERION	DESCRIPTION
Clear military need	The technology should demonstrate a significant improvement in the defense system.
Fully demonstrated, evaluated, and tested	The more information there is about the proposed technology, the less risk will be involved.
Cost-effective	Anything that drives down the cost of the weapon system has a far greater chance of success.

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## Advanced Technology Demonstrations

### Advanced Technology Demonstrations (ATDs)

Direct application of efforts in basic and applied research to systems application may be marginal. The technology produced in these two areas is not mature enough to transition directly to systems development. ATDs reduce the risk in transitioning from technology to systems.

Advanced Technology Demonstrations (ATDs) are:

- Projects funded using RDT&E Budget Category 6.3 (Advanced Technology Development).
- Intended to demonstrate technology feasibility and maturity.
- Designed to reduce technical risks and uncertainties at the relatively low cost of informal processes.

### Uses of ATDs

ATDs are hardware and software prototypes used for:

- Testing and evaluating non-system-specific solutions to refine basic and applied research.
- Preparing technology for systems development by demonstrating the feasibility and maturity of an approach at a relatively low cost.

### Managing and Funding ATDs

Following are important points to remember about ATDs. ATDs:

- Are usually managed by Federal laboratories.
- Demonstrate military utility of a technology before it is transitioned to an engineering community

- or program office.
- Are funded by Advanced Technology Development funds (6.3).

### **Advanced Technology Development Funds (6.3)**

This funding category includes all projects that have moved into the development of hardware for demonstration, proof of technology, and/or technological trade-off purposes. Both ATDs and ACTDs are funded with 6.3 funds.

### **Advanced Concept Technology Demonstrations (ACTDs)**

Advanced Concept Technology Demonstrations (ACTDs):

- Are a special case of ATDs, enhanced so that they can be fielded and used by operational forces.
- Were introduced in 1994 to enable rapid, cost-effective introduction of new capabilities.

DOD 5000.2-R recognizes ACTDs as Non-Acquisition programs that provide a means of demonstrating the use of mature technology to address critical military needs.

ACTDs are also:

- A means of demonstrating the use of emerging mature technology to address critical military needs.
- Not acquisition programs, although they are designed to provide a residual, usable capability upon completion.
- Funded to provide adequate support for at least 2 years of field operations.
- Funded with 6.3 (Advanced Technology Development (ATD)) funds.

According to DOD 5000.2-R (Para 2.7):

"ACTDs are a means of demonstrating the use of emerging or mature technology to address critical military needs. ACTDs themselves are not acquisition programs, although they are designed to provide a residual, usable capability upon completion. If the user determines that additional units can be funded, the additional buys shall constitute an acquisition program with an acquisition category generally commensurate with the dollar value and risk of the additional buy. The nature of the acquisition program depends on what additional development, if any, is needed upon completion of the ACTD. ACTDs shall conduct CAIV-based cost/schedule/performance tradeoffs throughout their planning and execution."

### **ACTD Characteristics**

ACTDs have the following characteristics:

- ACTD candidates are nominated by the services and selected by the Deputy Under Secretary of Defense (Advanced Technology).
- ACTDs focus on the user of the technology rather than the acquisition manager or laboratory.
- ACTDs use parallel demonstrations of technology and doctrine/tactics in an operational environment.

### **ATD and ACTD Objectives**

The objectives of each type of demonstration are shown below:

- ATD Objective: To assess potential military utility.
- ACTD Objective: To decide whether to invest resources based on military utility and requirements.

### **ACTD Key Points**

It is important to remember that ACTDs:

- Are selected at a very high Office of the Secretary of Defense (OSD) level, by the Deputy Under Secretary of Defense (Advanced Technology).
- Have a review panel.
- Emphasize parallel technology development and refinement of operational concepts in the field.
- Do not require all of the documentation that usually applies to acquisition programs.
- Require an informal management plan.



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